NASA

National Aeronautics and
Space Administration

Dryden Flight Research Center
P.O. Box 273
Edwards, California 93523
Voice 661-276-3449
FAX 661-276-3566
pao@dfrc.nasa.gov

Information Summary

IS-2000-10-013-DFRC

Aerospace Careers:
Flight Systems Planner

Integrating and testing new aircraft flight control systems are an important part of NASA's aeronautical research program. At the Dryden Flight Research Center engineers in the Flight Systems Branch carry out this work.

What are Flight Systems?

Modern aircraft flight systems are composed of integrated hardware components and computer software. The systems receive inputs, pass them through a set of hardware or software algorithms, and produce outputs that carry out certain tasks such as operating the aircraft's flight control surfaces. Flight systems also include aircraft data management systems, and units that monitor the "health" of propulsion, navigation and communications systems on an aircraft.

The most common example of a flight system is a modern jet aircraft's fly-by-wire flight control system. The pilot moving the control stick in the cockpit generates control inputs. The inputs are electronically sent to the flight control computer which senses what the pilot wants to do — bank, dive or climb. The flight control computer sends its signals to the aircraft's flight control surfaces, rudder, ailerons, elevators or stabilizers, which move to perform the desired maneuver.

A valuable tool developed by branch engineers was the Research Flight Control System (RFCS) used on the thrust-vectored F-18 aircraft that studied the flow of air over an aircraft at extremely high angles of attack. The aircraft was called the F-18 High Angle-of-Attack Research Vehicle (HARV).

Before a flight system is tested in an aircraft it must pass an exhaustive battery of simulator tests. At Dryden, hardware and software can be tested at the same time on the "Iron Bird" simulator, a complete non-flying airframe that electronically simulates all phases of flight to thoroughly test and evaluate an entire flight system

At Dryden, most flight systems are tailored for tasks beyond the realm of "normal" flight. Some aircraft, such as NASA's X-29 forward swept wing research aircraft, cannot fly without modern flight control systems because these aircraft are inherently unstable. The X-29 could not have left the ground without its computerized flight control system, which coupled the operation of the nose canards with the flight surfaces on the wings and tail to achieve very stable flight.

Flight systems also control the operation of thrustvectoring vanes used for directional control on the NASA's F-15 Advanced Control Technology for Integrated Vehicles (ACTIVE) research aircraft. A similar system was also used to control the thrustvectoring system on an F-18 that studied flight at extreme angles of attack. On both aircraft, flight system engineers coupled the thrust-vectoring unit with the primary flight control system.

In recent years the flight system arena at Dryden has broadened into data management systems that carry out in-flight diagnostic functions. These systems give research pilots and control room personnel on the ground an systems can reveal anomalies, such as slight drops in engine performance, before they become serious problems. This capability raises the safety level of research flying to new heights.

The Work of Flight Systems Engineers

Flight systems engineers work closely with many other disciplines as they help develop, test and evaluate new systems. Interfacing with controls engineers who design the software control laws, flight systems engineers make sure that the computer language is correct and functions called for by the research project are met.

Flight systems engineers also work hand-in-hand with research pilots and aircrews during each phase of systems development, integration and testing. This cooperative effort presents the perspective of the flight crew in areas of cockpit layout, operational simplicity and flight safety.

Before a flight system is tested in an aircraft it must pass an exhaustive battery of simulator tests. At Dryden, hardware and software can be tested at the same time on the "Iron Bird" simulator, a complete non-flying airframe that electronically simulates all phases of flight to thoroughly test and evaluate an entire flight system. The simulator not only gives flight systems engineers a stamp of approval on their hardware and software, it also allows them to develop procedures pilots will follow if problems develop during flight. Other simulators permit hardware and software to be tested and evaluated independently.

Flight systems engineers are usually in the mission control center during research fights, monitoring displays where information about the performance of aircraft systems is presented as the flight takes place. Systems telemetry being transmitted into the control room from the aircraft is usually being recorded at the same time so engineers and researchers can study data more closely at a later time.

The Tools of the Flight Systems Engineer

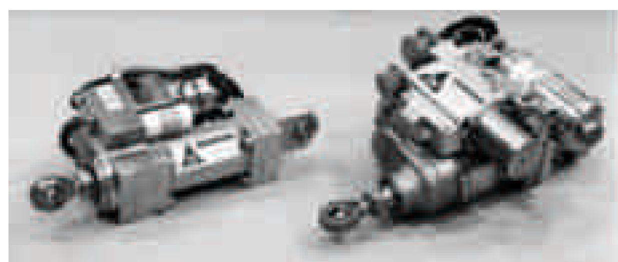
A valuable tool developed by branch engineers was the Research Flight Control System (RFCS) used on the thrust-vectored F-18 aircraft that studied the flow of air over an aircraft at extremely high angles of attack. The aircraft was called the F-18 High Alpha Research Vehicle (HARV). The RFCS allowed the HARV pilot, especially during high-risk flights, to maneuver the aircraft with software developed just for the thrust vectoring control system. The F-18's standard flight control system was still available; it was just by-passed during the research portions of the flight. In an emergency the pilot would only have to move a switch to activate the aircraft's normal flight control system. The RFCS worked perfectly, as designed by flight systems engineers, but was never needed in an actual emergency. The RFCS concept has been developed further and is now incorporated into Production Support Flight Control Computers (PSFCC) which are used extensively in flight testing.

Aircraft and spacecraft of the future will benefit from a branch project called Electrically Powered Actuation Design (EPAD). The work is centered on small selfcontained actuators designed to replace larger, and sometimes complicated, hydraulic units used to move flight control surfaces such as ailerons, rudders, stabilizers and flaps.

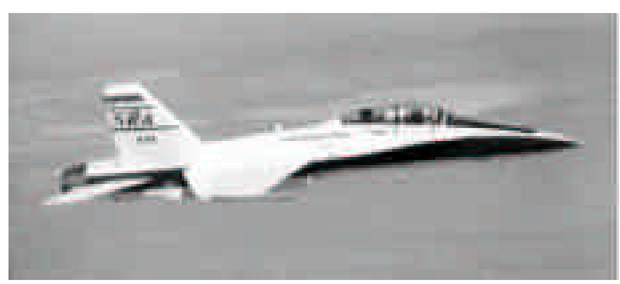
A spin-off of the Dryden EPAD project is a similar actuator flying on the X-38, which is testing the concept of a space station crew return vehicle, and the X-33 demonstrator for Reusable Launch Vehicle (RLV) technologies. On future air and space vehicles the smaller units will be lighter and smaller than conventional actuators. These factors can increase payload and reduce operational costs.

Dryden's F-18 Systems Research Aircraft (SRA) has been the testbed for two project actuators: an Electrohydrostatic Actuator (EHA), and an Electromechanical Actuator (EMA). Neither design relies on the aircraft's central hydraulic system to operate. The EHA carries its own fluid to function and the EMA uses an electrically driven screw to move the control surface.

Branch development of a vehicle health management system — a diagnostic unit that can predict an aircraft system failure before it



Dryden's F-18 Systems Research Aircraft (SRA).



The Electrohydrostatic Actuator (EHA) and an Electromechanical Actuator (EMA)

happens — is well underway with testing and evaluation of a prototype unit on Dryden's F-18 SRA. The next step in the vehicle health management development program is expected to be the X-33 to monitor the structural integrity of the rocket-powered test vehicle at speeds of up to 12,000 mph while under a variety of aerodynamic loads..

Education and Experience

Individuals interested in a career as a NASA flight systems engineer should possess a bachelor of science degree in aeronautical, electrical, mechanical engineering or another discipline related to aerospace technology. They should also have a solid background in mathematics and science, and they should understand the fundamentals of aeronautical research.

Flight systems engineers must also have excellent problem-solving skills and have the ability to work independently, with minimal supervision.

Strong skills in computer operations and programming are necessary, along with the ability to communicate with researchers and engineers of all disciplines and at all levels of management, not only at Dryden but with individuals at other NASA centers, other government agencies, and commercial aerospace firms.

Most major aerospace companies have facilities where engineers work in positions that would provide career experience for a future NASA flight systems engineers. Within the federal government, similar engineering positions can be found in the Federal Aviation Administration and also in the flight test branches of the U.S. armed forces.